

critics should have fastened on quite subsidiary matters and left his main contention unacknowledged.

I feel bound to admit that in some respects Prof. Armstrong has overstated his case. His advocacy has suggested that he desires the pupil to discover everything for himself and by himself, and so is incurred the criticism that it is ridiculous to expect a child to achieve in two or three years that which it has taken grown philosophers centuries of labour to achieve. A beginner cannot discover much for himself by himself, but a judicious teacher may lead him to discover much. I think that Prof. Armstrong has exaggerated the importance of quantitative work, great though that importance be. One has only to think of the achievements of Scheele in order to realise what a splendid thing qualitative work may be when faithfully performed. Again, the element of useful information must not be underestimated; we want to get the pupil along, and there is surely much that may be told, if it is properly presented and punctuated with experiments. In doing this there is no need to throw the pupil into a state of passive acceptance, still less of passive resistance; a good teacher knows how to avoid either.

Another point on which Prof. Armstrong's critics have fastened is his nomenclature. This is really a trifling matter, but such as it is I am on the side of the critics. "Chalk gas" seems unnecessary, even as a temporary name for carbon dioxide. Why not fixed air, which is both descriptive and historical? However, as I have said, such things are mere trifles.

In conclusion, I will express the opinion that it is not the matter of Prof. Armstrong's proposals that has created opposition, but the manner. There is probably no decent member of society more repugnant to the average Englishman than the aggressive educational reformer. If a man quietly records in books the outcome of his mature reflections and experience—well, you can avoid him by not reading his book, but if he appears at all your meetings with his new doctrines, if he invents new terms that dart promiscuously about the atmosphere of the educational world, and if eventually he gets known to the newspapers as a man likely to furnish occasion for the headline "animated debate," it is quite otherwise. If a man is a stylist like Matthew Arnold, deft with epigram, breathing a cultivated irony, he is forgiven everything for his literary excellence. But Prof. Armstrong has not chosen the persuasive method of Matthew Arnold. He is vigorous almost to violence, red-hot, scathing, scornful, uncompromising and incessant. He is no respecter of persons or institutions, however eminent, however ancient. He is absolutely impartial in his iconoclasm.

These peculiarities may have hindered the acceptance of improved methods. In any case, improvement could only have come in slowly, for it is laborious, and taxes the ingenuity as well as the diligence of the teacher. The eagerness of public administrators for speedy results, the false economy which gives the teacher no time to think, and the crowding of elementary classes, not only in the case of science, but all through the school course, are great obstacles to thoroughness.

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How idle it is to preach improved methods to an over-worked teacher who has seventy, eighty or a hundred children to teach at once!

When all reasonable concessions have been made to his critics, it will, I believe, appear that Prof. Armstrong has rendered an inestimable service to the cause of true education.

ARTHUR SMITHIELLS.

PRACTICAL ZOOLOGY.

First Report on Economic Zoology. By Fred. V. Theobald, M.A. Pp. xxxiv+192; 18 figures. (London: Printed by Order of the Trustees of the British Museum, 1903.) Price 6s.

THIS volume of reports on problems of economic zoology is very welcome. It represents a type of publication familiar in America, which has never been more than very rare in Britain; it is packed with valuable practical advice which must surely justify zoology in the eyes of any unconverted utilitarian; and it illustrates the nature and amount of scientific information on matters of economic importance which the staff of the zoological department of the British Museum "is almost daily called upon, and is prepared to furnish to the public service or to individuals." As is well known, this side of the Museum's work has been brought into particular prominence since Prof. Ray Lankester became director.

The contents are necessarily very heterogeneous, and afford a fine illustration of the multitudinous ways in which man's practical interests come into contact with animal life. We find discussions on cereal pests, root-crop pests, fruit pests, garden pests, forest pests, on poison for moles, on tapeworm in sheep, on the origin and varieties of domesticated geese, on dipterous larvae in human excreta, on *Anobium tessellatum* in St. Albans Cathedral, on green matter in Lewes Public Baths, on the cigar beetle and the Terebra, on the tsetse fly and the Ceylon pearl fisheries, on the screw worm in St. Lucia, locusts in the Sudan, mosquitoes at Blackheath, and so on through a variety of subjects that is positively astounding. Mr. Theobald deserves warm congratulation on the impressiveness of his "First Report."

The variety of subjects which have had to be discussed in response to inquiries from the Board of Agriculture, the Foreign Office, the Colonial Office, and from private individuals makes the volume very multifarious, and gives a special appositeness to Prof. Ray Lankester's introductory scheme or outline of economic zoology. He gives a classified survey of the various subdivisions which it is found convenient to recognise in the treatment of this subject. This classification of animals in their economic relation to man, which recalls a little book by Dr. Edwin Lankester, proceeds from the simpler relations of primitive man and the animals around him to the more complex relations of civilised man with his endless arts and industries and circumscribed conditions. We give the classification in outline:—

Group A.—Animals captured or slaughtered by man for food, or for the use by him in other ways, of their skin, bone, fat, or other products. Examples:—

animals of the chase; food-fishes; whales; pearl-mussels.

Group B.—Animals bred or cultivated by man for food or for the use of their products in industry or for their services as living things. *Examples*:—flocks and herds; horses; dogs; poultry; gold-fish; bees; silkworms and leeches.

Group C.—Animals which directly promote man's operations as a civilised being without being killed, captured or trained by him. *Examples*:—scavengers such as vultures; carrion-feeding insects; earthworms and flower-fertilising insects.

Group D.—Animals which concern man as causing bodily injury, sometimes death, to him, and in other cases disease, often of a deadly character. *Examples*:—lions; wolves; snakes; stinging and parasitic insects; disease-germ carriers, as flies and mosquitoes; parasitic worms; parasitic Protozoa.

Group E.—Animals which concern man as causing bodily injury or disease (both possibly of a deadly character) to (a) his stock of domesticated animals; or (b) to his vegetable plantations; or (c) to wild animals in the preservation of which he is interested; or (d) to wild plants in the preservation of which he is interested. *Examples*:—Similar to those of Group D, but also insects and worms which destroy crops, fruit and forest trees, and pests such as frugivorous birds, rabbits and voles.

Group F.—Animals which concern man as being destructive to his worked up products of art and industry, such as (a) his various works, buildings, larger constructions and habitations; (b) furniture, books, drapery and clothing; (c) his food and his stores. *Examples*:—White ants; wood-eating larvæ; clothes' moths, weevils, acari and marine borers.

Group G.—Animals which are known as "beneficials" on account of their being destructive to or checking the increase of the injurious animals classed under Groups D, E, and F. *Examples*:—Certain carnivorous and insectivorous birds, reptiles and Amphibia; parasitic and predaceous insects, acari, myriapods, &c.

We have, then, in this "First Report on Economic Zoology" a large number of expert discussions of particular points—all of practical importance and some of theoretical interest as well; and we have also a luminous orientation of the whole subject. No one can help being impressed by the fact that zoology does not lose either in interest or in thoroughness as it becomes more social.

J. A. T.

IRRIGATION WORKS.

Irrigation Engineering. By Herbert M. Wilson, C.E. Fourth edition. Pp. xxiii+573. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 17s. net.

AN annual grant of about 500,000*l.* having been recently allotted by the Congress of the United States for the construction of irrigation works in arid regions, under the supervision of the director of the Geological Survey, various projects have been prepared

with a view to their execution in the near future; which have already given employment to a number of engineers. This development has enhanced the importance of a sound knowledge of the principles of irrigation engineering, and has, accordingly, led the author to revise thoroughly and enlarge his book on the subject.

The area of land irrigated in the United States, reaching more than $7\frac{1}{2}$ million acres, is second only to India with 33 million acres, being larger than the irrigated area in Egypt of 6 million acres, in Italy of $4\frac{7}{10}$ million acres, and in Spain of $2\frac{1}{2}$ million acres. The States in which irrigation has been most resorted to are Colorado, California, Montana, Utah, and Idaho, with irrigated lands ranging from $1\frac{1}{2}$ million to half a million acres. After a very short introductory chapter on irrigation, the book is divided into three parts, dealing with hydrography, irrigation canals and canal works, and storage reservoirs respectively, in nineteen chapters altogether.

The subjects treated of in the first and third parts are, for the most part, similar to those contained in books on water-supply, the chief exceptions being chapter iv., on alkali, drainage, and sedimentation; chapter v., on the quantity of water required; and the end portion of the last chapter in part i., relating to sewage irrigation, which belongs strictly to sewage disposal. When the drainage of irrigated lands is not efficiently provided for, and an excess of water is carelessly distributed, any alkali in solution in the water accumulates by the evaporation which occurs as soon as the water rises to the surface, sodium carbonate being the most injurious to the soil; and the land also becomes water-logged and swampy, which, besides being bad for agriculture, is liable to occasion malarial fevers. Silt, which is brought down in large quantities in flood-time by many rivers, the waters of which are used for irrigation, is very valuable as a manure if it can be spread over the land, but it is very liable to deposit in the storage reservoirs and canals provided for irrigation, before the water reaches its destination; and the aim of the engineer is to convey the lighter and more fertile silt on to the land with the water, and to arrest the heavier silt before it reaches the reservoir, or to scour it out through sluices in the dam; and in the case of a diversion canal from a river, to arrange its entrance so as to keep out most of the heavier silt, and to make the remainder deposit in a part of the canal from whence it can be readily removed. The amount of water required to irrigate a given area depends upon the conditions of the locality and the crops raised, and forms the basis of all irrigation schemes.

The second part deals with works relating exclusively to irrigation in seven chapters, in which inundation and perennial canals, their alignment, slope, and cross section, headworks and diversion weirs, scouring sluices, regulators and escapes, falls and drainage works, distributaries and the application of water and pipe irrigation, are successively considered; and this constitutes the most important part of the book as regards irrigation. The book, however, as a whole, deals with the principles and practice of irrigation in a very complete manner, and is profusely illus-